Experiment P06: Measuring the Acceleration of a Freely Falling Picket Fence (Photogate)

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Object:

The purpose of this laboratory activity is to measure the acceleration due to gravity by measuring the time of fall of a "picket fence" dropped through a photogate.

EQUIPMENT NEEDED

Science Workshop™ Interface, picket fence, photogate or Smart Pulley, table clamp (optional), and program file:P06_FALL.

THEORY

As an object falls freely, it accelerates due to the applied net force. If air resistance is neglected, and the speed of the object is measured over several short, consecutive intervals as it falls, the differences in the speed of the object can be used to determine the acceleration due to gravity.

PROCEDURE

In this activity, you will drop a "picket fence" (a clear plastic strip with uniformly spaced opaque bands) through a photogate. The photogate beam is blocked by each opaque band and the time from one blockage to the next becomes increasingly shorter. Knowing the distance between the leading edge of each opaque band, the *Science Workshop* program calculates the average speed of the picket fence from one band to the next. A graph of average speeds versus time can give the acceleration due to gravity of the falling object.

PART I: Computer Setup

1. Connect the *Science Workshop* interface to the computer, turn on the interface and then turn on the computer.

2. Connect the photogate's stereo phone plug to Digital Channel 1 on the interface.

3. Open the physics lab folder found on the desktop screen and open file titled as shown; P06_FALL.

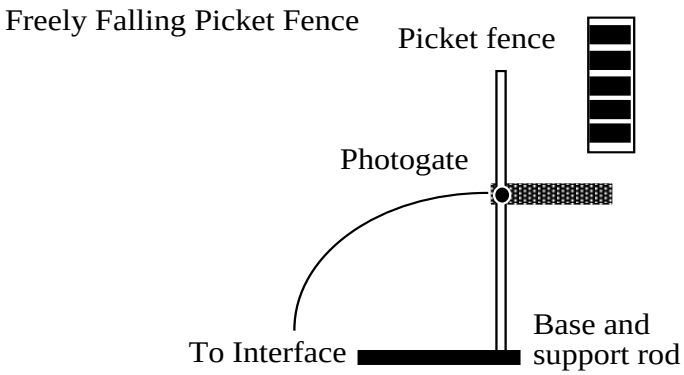
- The document will open with a Graph display that has plots of Position and Velocity versus Time and a Table of Position, Velocity, and Acceleration versus Time.

- (Note: For quick reference, see the Experiment Notes window. To bring a display to the top, click on its window or select the name of the display from the list at the end of the Display menu. Change the Experiment Setup window by clicking on the "Zoom" box or the Restore button in the upper right hand corner of that window.)

PART II: Equipment Setup

- The *Science Workshop* program assumes a 5 cm (0.05 m) spacing, leading-edge-to-leading-edge, for the opaque bands on the picket fence. To change the default setting to another value, double-click on the icon of the photogate in the Experiment Setup window. Enter the correct value for the spacing of the opaque bands on your picket fence. Click OK.

1. Turn the photogate head of the accessory photogate sideways so that you can drop a picket fence vertically from above the photogate and have the picket fence move through the photogate's opening without hitting the photogate.



(If you are using a Smart Pulley photogate, you may want to put the Smart Pulley's mounting rod horizontally in a table clamp and then fasten the clamp on the edge of a table. Again, turn the Smart Pulley photogate so that a picket fence can be dropped through the photogate's opening.)

Preparing to Record Data

- Before recording any data for later analysis, you should experiment with the photogate and picket.

- Click the "Start" button in the Experiment Setup window. Drop the picket fence vertically through the photogate. Data recording begins when the photogate beam is first blocked. Click "STOP" to end recording of your sample data. Click the "Autoscale" button in the Graph display.

- To erase a trial run of data, select "Run #1" in the Data Sets list …

  …and press the "Delete" key.

PART III: Data Recording

1. Prepare to drop the picket fence through the photogate beam. Hold the picket fence at one end between your thumb and forefinger so the bottom edge of the picket fence is just above the photogate beam.

2. Click the "start" button and then drop the picket fence through the photogate beam. Remember, data collection begins when the photogate beam is first blocked.

3. When the picket fence is through the beam, click "STOP" to end recording. (The position, velocity, and acceleration values should appear in the Table display and "Run #1" should appear in the Data Sets list.).

DATA ANALYSIS

1. The coefficient **m** is the slope of the 'best fit' line. This slope is the value of the acceleration of the falling picket fence. Record this value in the Data Table.

2. Click on the Table displayed. Click the $\sum$ button. Statistics for minimum, maximum, mean, and standard deviation will appear in the bottom rows of each table column.

3. Record the displayed value for the Mean of the acceleration of the picket fence in the Data Table.

DATA TABLE

slope of velocity versus time = _____ (from Graph display)

acceleration (mean) = _____ (from Table display)

QUESTIONS

1. How does the slope of your velocity versus time plot compare to the accepted value of the acceleration of a free falling object ($g = 9.8\ m/s^2$)?

- Reminder: percent-discrepancy $= \left| \frac{accepted\ value - experimental\ value}{accepted\ value} \right| x100\%$

2. How does the mean of the acceleration from the table compare to the accepted value of the acceleration of a free falling object ($g = 9.8\ m/s^2$)?

3. What factors do you think may cause the experimental value to be different from the accepted value?